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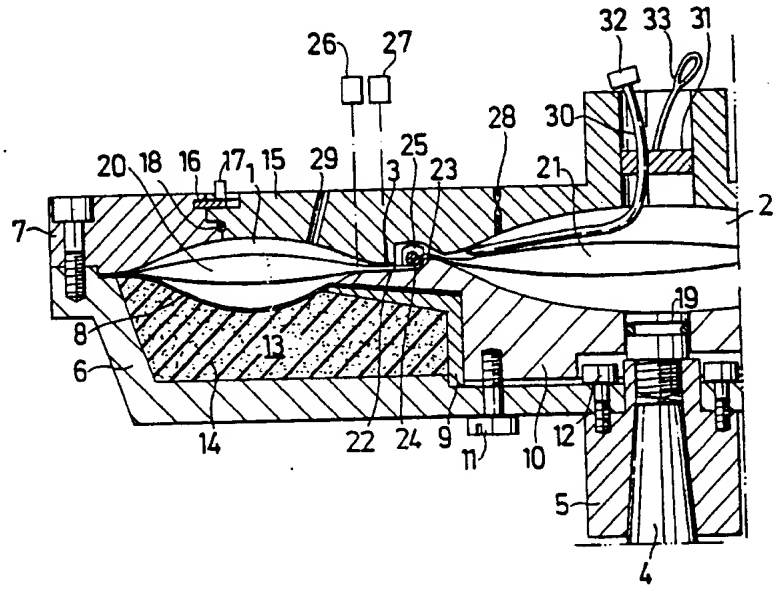

(57) Abstract

A centrifuge apparatus for batch centrifugal separation of a liquid, preferably blood and other biological liquid. The separation is carried out in a flexible collapsible annular container (20) connected to one or more component containers (21). An annular separation compartment (1) receiving the flexible annular container (20) is provided in the centrifuge apparatus. Moreover, the apparatus is provided with a pressure medium compartment (13) communicating with the separation compartment and holding an elastic body (14) adapted during the centrifugation to be pressed against the separation compartment by the action of the centrifugal field and to exert pressure on the annular container positioned in the separation compartment. A separated component is thereby expelled to a component container (21) during the centrifugation. The centrifuge apparatus is particularly suited for carrying out plasmapheresis.

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Annular centrifuge

This invention relates to centrifuges for batch separation of liquids into components. More particularly, the invention relates to a centrifuge for separation of liquids requiring gentle treatment, such as blood and other biological fluids containing live cells, the separation being carried out in a flexible annular container positioned in the centrifuge and a separated component being transferred to a component container during the centrifugation.

In this context, liquids also include suspensions and highly viscous materials, such as blood cells obtained from whole blood after the plasma has been separated.

The invention is particularly suitable for carrying out plasmapheresis, which is the harvesting of a certain amount of plasma from a blood donor without causing damage to or loss of blood cells, it being essential to do this as quickly and economically as possible and in satisfactory safety conditions.

These requirements can be met to a high degree by a centrifuge embodying the invention. When carrying out plasmapheresis in the customary manner (usually two-cycle plasmapheresis), blood is withdrawn in two successive donations from a donor and passed into a sterile assembly of interconnected rectangular plastic containers which are centrifuged in a large blood centrifuge following each donation. The commonly used centrifuges receive 6 to 12 blood units for each run and the blood donor has to wait until a centrifuge rotor is fully loaded before his blood is centrifuged so that his blood cells can be returned to him.

From U.S. Patents Nos. 3,708,110 and 3,858,796 it is known for the purpose of fractionating blood and washing blood cells to use annular containers in which different components and processing liquids are transferred from one compartment to another in multiple-compartment annular containers by means of, for example, a pump structure incorporated in one of the containers. Such containers and

centrifuges, however, are too expensive e.g. for routine harvest of plasma from donors (so-called plasmapheresis).

It is also known to transfer a component from one container to another by means of a displacement liquid pumped by a pump device located outside the centrifuge head. However, the rotary liquid flow connectors which are required in this case are expensive because of their structure and they are not very reliable.

An object of the present invention is to provide a centrifuge apparatus for gentle and efficient separation of liquids, especially blood and other biological liquids, in which the afore-mentioned disadvantages of known types of centrifuges are eliminated. Accordingly, the centrifuge apparatus according to the invention comprises a simple and reliable system for transferring a separated component from an annular container to a component container while the liquid is being subjected to the centrifugal field of the centrifuge, without any manually or exteriorly controlled steps influencing the operation of the centrifuge being required.

A further object of the present invention is to provide simple, reliable and easy-to-handle plasmapheresis equipment suitable for use in mobile donation units, such as blood buses.

These and other objects and advantages, which will become apparent from the following description, are realized according to the invention by the centrifuge apparatus defined in the claims.

The centrifuge apparatus according to the invention comprises a centrifuge head in which are provided an annular separation compartment for receiving a flexible collapsible annular container connected to one or more component containers, and a pressure medium compartment communicating with the separation compartment and holding an elastic body. The elastic body is designed during the centrifugation to be influenced by the centrifugal field so as to be urged against the separation compartment and thereby to exert pressure on the annular container received in the separation compartment, and is adapted to

exert a pressure on the annular container exceeding the pressure of the liquid held in the annular container. For example, the density of the elastic body may be substantially greater than that of the liquid in the annular container, or it may have inserts in the form of heavier bodies which act like plungers to urge the body against the separation compartment.

According to a preferred embodiment the pressure medium compartment is annular and the pressure medium is an annular elastic body disposed in this compartment and communicating with the separation compartment through an annular opening between the two compartments. The communication may take place through the intermediary of an annular diaphragm disposed in this opening.

The component container or containers are positioned in a central compartment in the central portion of the centrifuge head and, accordingly, also rotate. Rotary connectors in the pathway between the annular container and the component container or containers can thus be dispensed with.

The separation compartment and the central compartment communicate with one another through a slot-like connecting zone. This feature permits the use of practical bag assemblies in which the annular container and the component container or containers are interconnected and are handled as a unit.

For additionally improving the usefulness of the centrifuge apparatus, especially for plasmapheresis and other blood processing operations immediately following the withdrawal of blood from a blood donor or a patient, the centrifuge may be equipped with a system for filling and emptying the annular container while it is positioned in the centrifuge head. To this end, the separation compartment is pressurized or subjected to vacuum through an air pressure or vacuum connection on the centrifuge head. During the filling or emptying steps the centrifuge motor may be operated to effect a reciprocatory agitating movement. The filling step may also be discontinued automatically by causing the annular container, when it

has received a predetermined volume, to block the vacuum connection.

The elastic body may be adapted to exert pressure on the annular container whenever the centrifuge head is rotating. In that case, the transfer of a separated component to the component container is governed by one or more valves which control the communication between the annular container and the component container. Normally, the valves block the communication, and they open it when transfer is to be effected. The valves may be centrifugally controlled and set to open at a given rotational speed which is higher than the normal operating speed.

The structure of the valves and their opening and closing characteristics may be adapted for the intended use of the centrifuge. However, in the case of separation requiring sterile conditions it is preferred to use pinch valves which squeeze collapsible connecting ducts between the containers. In such case, the containers may be interconnected to form a closed system so as to communicate with one another without exposing their contents to the ambient atmosphere.

The invention will be described in greater detail with reference to the accompanying drawings, in which:

Fig. 1 shows one embodiment of a centrifuge head for a centrifuge apparatus according to the invention;

Fig. 2 is a plan view of the centrifuge head with the cover removed;

Fig. 3 shows a centrifugally controlled pinch valve for a centrifuge head according to the invention;

Fig. 4 shows a valve device for a centrifuge head according to the invention, the valve device being in the form of an annular pinch member;

Fig. 5 shows an interlocking and agitating device for a centrifuge head according to the invention;

Fig. 6 shows an alternative embodiment of the pressure medium compartment and the elastic body in a centrifuge head according to the invention.

In the centrifuge head of Figs. 1 and 2, numeral 1 designates an annular separation compartment which extends

about the centrifuge head along its periphery. A central compartment 2 communicates with the separation compartment through a slot-like connecting zone 3. A centrifuge cone 4 is driven by a programme-controlled motor (not shown) and fits in a hub 5 of the centrifuge head. Numeral 6 designates a rotationally generated bowl-shaped lower portion of the head against which an upper ring 7 is permanently clamped. Between parts 6 and 7 an elastic annular diaphragm 8 is clamped. The inner edge of the diaphragm 8 is clamped between rotationally symmetrical parts 9 and 10, part 10 being clamped to the bowl 6 by means of a number of screws 11. Bowl 6, in turn, is clamped to the hub 5 by a number of screws 12. The space between parts 6, 8 and 9 forms an annular pressure medium compartment 13 which is occupied by an elastic body 14 consisting of, for example, latex rubber mixed with metal powder. The elastic body has to have substantially greater density than the liquid to be separated in the centrifuge. This can be accomplished by, in addition to admixture of metal powder and other solid materials, inserts 49, 57 (Figs. 5 and 6) of metal, for example, in the portion of the body closest to the centre of rotation.

Numeral 15 designates a transparent cover of the centrifuge head which is readily removable because it is held by a snap ring 16. When expanded, the ring 16 partially engages a groove in the ring 7 and partially remains in a relatively deep groove in the part 15 so that it holds these parts together. The ends 17 of the ring 16 are turned up from the body of the ring and extend through an opening in part 15 and beyond that part so that they can be gripped. By pressing the ends 17 together the diameter of the ring is decreased so that the ring and part 15 can be fitted into the ring 7 and locked to it when the ends 17 are released. An O-ring 18 provides a seal between parts 7 and 15. A sealing screw 19 provided with an O-ring prevents any liquid coming out into the centrifuge head from escaping into the lower portions of the head.

A flexible collapsible annular container 20 communicates with a component container 21 by way of a collapsible connecting duct 22. The annular container 20 is intended to receive a batch of liquid to be centrifuged, such as a blood donation, and the component container 21 is intended to collect a lighter component, such as plasma, separated through the centrifugation. The annular container 20 is somewhat excentric, having its greatest radial dimension at the connecting duct 22, to prevent a heavier component from being drawn into the component container while the annular container still holds a quantity of the lighter component.

Numerals 23-25 designate a centrifugally controlled pinch valve. In the embodiment shown, it consists of a rubber rope 24 which urges the collapsible connecting duct 22 against a shoulder 23. The annular container and the component container are positioned in the centrifuge so that the collapsible connecting duct 22 is positioned over the shoulder 23. The rubber rope 24, which is guided axially by a guide 25 on opposite sides of the shoulder 23, clamps the duct 22 against the shoulder so that the duct is closed. The tension of the rubber rope is selected such that the rope is lifted from the duct 22 by the centrifugal force to open the duct only when the speed of the centrifuge exceeds the predetermined separation speed. Two photocells 26 and 27 indicate and signal to the programme control if blood or plasma, for example, is in their light path.

The interior of the centrifuge communicates with the atmosphere outside the centrifuge head through a passage 28 provided with a constriction. By way of an air pressure of vacuum connection 29 the separation compartment may be subjected to overpressure or vacuum when the annular container is emptied and filled.

Through a flexible tube 30 the annular container can be linked with a container, blood donor or the like outside the centrifuge by way of a connector 32. A sealing member 31 fixedly secured to the tube 30 seals the interior of the centrifuge from the exterior (disregarding the

constriction 28 and the connection 29) when it is pulled into a firmly seated position in the cover 15 using the pull rope 33.

The centrifuge apparatus according to the invention has many different applications. However, it is particularly suitable for separation of blood, and in particular for separation of blood immediately following the withdrawal of blood from a blood donor or a patient.

With reference to Figs. 1 and 2 the operation of the invention will now be described in connection with its application to plasmapheresis.

The containers 20-21 are positioned in the centrifuge head with the duct 22 disposed over the shoulder 23 and secured by means of the rubber rope 24 so that the communication between the containers is blocked. In addition, the containers are retained in position by means of a number of locating pins (not shown).

The cover 15 is brought in position and secured by means of the ring 16 as described above. Beforehand, the annular container 20 has been primed with a suitable quantity of anticoagulant. The connector 32 is attached to a standard blood donation kit which is also linked with the blood donor. Because the centrifuge is positioned at a comfortable working height, the hydrostatic negative pressure from the donor to the container is insufficient for normal withdrawal of blood. A vacuum pump (not shown) connected to the passage 29 provides, by virtue of the constriction 28, the desired increased vacuum. Blood flows from the donor into the annular container 20. In order that proper admixture of anticoagulant in the blood may be ensured, the centrifuge is programmed to oscillate at a predetermined amplitude and a predetermined frequency during this phase. As the annular container 20 is becoming filled with blood, its upper wall approaches the underside of the cover 15. When the container has been filled, the flexible annular container closes the passage 29, and the vacuum produced by the vacuum pump increases because the constriction 28 is blocked. Attention is then called to the attendant and the withdrawal of blood is discontinued.

The blood donation kit is separated from the connector 32, and the blood donor in the customary manner is supplied with saline to replace the donated blood and to keep the blood withdrawal tubes clean.

Initially, the centrifuge operates at the normal separation speed, the duct 22 then being maintained in closed condition. Because the elastic body 14 has greater density than the blood and extends farther towards the centre than the blood, the overpressure generated in the container 20 is substantially higher than the overpressure generated by the blood. However, since the duct 22 is closed, the blood is trapped. After a given time has elapsed, the centrifuge speed is slightly increased, so that the centrifugal force lifts the rubber rope 24 from the duct 22 which is accordingly opened to permit the separated plasma to flow to the component container 21. The radial height of the column of blood then becomes greater that that of the rubber, but because of the greater pressure action of the rubber, plasma continues to flow into the container 21. When the container 20 has run out of pure plasma , cells reach the light path of the photocell 27, and under the action of the programme control or a computer the centrifuge speed is reduced to the lower value at which the valve 23-25 closes. Plasma is still being separated from the cells, however, although at a reduced rate, and when the plasma reaches the light path of the photocell 26, the centrifuge speed is again increased so that the valve 23-25 is opened and a further quantity of plasma is conveyed into the component container 21. The provision of two photocells permits slow transfer of plasma while the separation is still going on, resulting in saving of time.

After a predetermined time has elapsed the centrifuge is stopped and the rubber body resumes its original shape, and because plasma has been expelled from the annular container 20, there is now space for a different liquid. Diluting liquid (physiological saline) is now fed to the annular container by way of the connector 32 while the centrifuge head is again being oscillated. When the cell

concentrate has been diluted to the desired concentration, the separation compartment 1 is subjected to a predetermined overpressure by pumping air into it by way of the passage 29. The contents of the annular container 20 then flow to the donor by way of an air-trapping vessel and a transfusion kit including a filter. The first phase of the two-cycle pheresis is completed when the annular container is empty. The cover 15 is removed and the duct 22 is sealed and cut, e.g. by means of a pair of heat-sealing jaws. The annular container and the component container are removed and replaced by a new container assembly for repetition of the above-described procedure. According to a modification, the component container 21 is large enough to accommodate two batches of plasma, and in such case both separations are made in the same container. According to this modification, the priming anticoagulant in the annular container has to be replaced by anticoagulant fed continuously by way of the blood donation kit, or the container assembly in the centrifuge has to be heparin coated so that coagulation is avoided.

Alternative embodiments are contemplated. For example, the communication between the annular container and the component container may be provided by a flexible tube, and the centrifugally operated pinch valve 23-25 may be replaced by a tube pinch valve as shown in Fig. 3 or by an annular pinch member as shown in Fig. 4. The volume of elastic material in the body 14 may be reduced by providing it with internal passages and weight segments, a metal braid or the like at the portion closest to the centre to increase its pressure action on the annular container 20, as will be described with reference to Fig. 6.

In Fig. 3, numeral 34 designates a flexible connecting tube between the annular container 20 and the component container 21. The tube pinch valve comprises a fixed support 35 and a fixed guide 36 which accommodates a slidable closing cylinder 37 having a chisel tip 38 engaging the flexible tube 34. A spring 39 urges the cylinder 37 towards the support 35 to pinch the flexible

tube 34. The guide 36 extends radially, and when a predetermined rotational speed is reached, the centrifugal force on the cylinder overcomes the spring force so that the valve opens. The valve may be provided on the cover of the centrifuge, and the flexible tube 34 may have a length such that it can be pulled into a central opening in the cover and positioned in the gap between the support 35 and the cylinder 37.

A still further valve arrangement is shown diagramatically in Fig. 4. In this case the valve comprises an annular pinch member 41 disposed in the cover of the centrifuge head within the slot-like zone between the separation compartment 20 and the central compartment 21. A groove 40 in the cover accommodates the annular pinch member 41. A number of springs 42 urge the pinch member downwardly to close the slot-like passage between the separation compartment and the central compartment.

At a number of symmetrically distributed locations along the pinch member, radial rods 43 are slidably received in slots 44 formed in the pinch member. A weight 45 forms a terminal end of the radially outwardly directed portions of the rods and rests on a radially inwardly directed spring or resilient body 46. The height profile of the rods 43 varies in a special fashion along the length of the rods.

When the centrifuge head reaches a certain given rotational speed, the centrifugal force on the weight 45 and the rod 43 overcomes the force of the spring 46 so that the rods 43 are displaced radially outwardly. As the ascending height profile of the rods moves through the slots 44, the pinch member is lifted so that the slot-like connecting passage between the separation compartment and the central compartment is opened. By modifying the height profile, different opening characteristics of the valve can be realized. If the rotational speed is reduced, the procedure is reversed so that the valve is reclosed. However, it is possible to design the profile such that the valve closes upon further increase of the rotational speed, e.g. by providing a stepped drop of the height

profile, whereby when the speed is increased the pinch member drops, closes the valve and also latches the rods in their outer positions.

In a valve arrangement of the above-described type it is possible to use a disc-shaped flexible bag, the annular container and the component container being separated only by means of the pinch member after the bag has been placed in the centrifuge head and the cover has been brought in position. Liquid is supplied to the annular container through a tube 47 and is discharged from the component container through a tube 48. This arrangement may be particularly advantageous in connection with component production in which buffy-coat is isolated in the component container defined by the pinch member, while plasma is expelled through the tube 48 into a second component container. Buffy-coat is difficult to expel from the annular container into a component container by way of a valved tube and to be obtained in pure form, because it is viscous and constitutes only a relatively small volume of a blood batch. A valve opening extending along the entire inner periphery of the annular container, as is obtained by the use of the pinch member 41, facilitates the isolation of the buffy-coat.

Fig. 5 is a detailed view of an agitating and latching device for a centrifuge head according to the invention. Like reference numerals are used for corresponding parts in Figs. 1, 2 and Fig. 5. Numeral 50 designates a central cover portion of a larger cover 51 of the casing enclosing the centrifuge. The larger cover is opened only when the centrifuge head is to be opened, while the cover portion 50 is used when connecting flexible tubes between containers in the centrifuge head, on the one hand, and a container, blood donor or the like exteriorly of the centrifuge, on the other hand. A brake spring arm has one end thereof secured to the underside of the larger cover 51 and at the other end thereof is provided with a latch pin 53 which can be caused to engage a corresponding recess 54 in the centrifuge head. On its upper side the cover portion 50 is provided with a pin 55 which upon

folding the cover portion upwardly to open position pushes the spring arm 52 such that the latch pin 53 is caused to engage the recess 54. The centrifuge head can then be turned only through a portion of a full turn and is returned to the original position by the spring arm 52. Momentary activation of centrifuge motor causes a reciprocating movement of the centrifuge head, resulting in an efficient agitation of the liquid in the annular container. This agitation can be utilized during blood withdrawal to mix the incoming blood with anti-coagulant, such as CPD solution, in the annular container and to resuspend the cell concentrate in physiological saline during plasmapheresis, or for washing processes, etc. The arrangement also constitutes a safety interlock which prevents inadvertent rotation of the centrifuge head when flexible tubes are connected between containers in the centrifuge head and a blood donor, for example. The cover portion 50 always is open when such tubes are connected and the safety interlock accordingly is activated.

Fig. 6 shows a cross-section through one half of a centrifuge head according to the invention in which the pressure medium compartment and the elastic body are partly modified in comparison with Figs. 1 and 5. Like reference numerals are used for corresponding parts in Figs. 1, 2, 5 and 6. In this case, the annular elastic body 14 forms the entire bottom of the separation compartment 1 and also forms a thinner bottom portion 56 of the central compartment. A braid 57 of metal wire forms part of the elastic body. The metal braid extends along the radially inner annular portion of the body. It has great density and is extendable so that its circumference can be elongated, and it accordingly amplifies the pressure action of the body 14 against the separation compartment during the centrifugation. Moreover, an annular body 58 filled with liquid is embedded in the elastic body. To this end, a liquid-filled tube may be cast into a silicon rubber body, for example. Numeral 59 designates the wall of such an embedded tube.

Because of this design, the deformation energy stored in the body 14 is reduced and an increased pressure action is achieved at lower speed. The direction of the deformation can be controlled and the deformation losses can be reduced by the positioning and design of the liquid-filled embedded body.

Instead of a metal braid 57, it is of course possible also to use annularly arranged metal segments 49 as shown in Fig. 5, or heavier solid material, such as granules of lead embedded in the elastic body. The granules may be uniformly distributed in the annular body 14 or concentrated to the radially inner portion, that is, to an area where the metal braid is positioned in the illustrated embodiment.

Claims

1. A centrifuge apparatus for batch centrifugal separation of a liquid, preferably blood and the like, comprising a centrifuge head driven by a programme-controlled motor, characterised

in that the centrifuge head comprises

a) an annular separation compartment (1) receptive of a flexible, collapsible annular container (20),

b) a central compartment (2) located inwardly of the separation compartment in the central region of the centrifuge head and receptive of one or more component containers (21) connected to the annular container,

c) a cover (15) by which the separation compartment and the central compartment can be uncovered at least partially to permit positioning in the centrifuge head of a flexible bag assembly comprising the annular container and one or more component containers, and

d) a pressure medium compartment (13) communicating with the separation compartment and holding an elastic body (14) adapted by virtue of the centrifugal field during the centrifugation to exert pressure on the annular container (20) received in the separation compartment so as to displace liquid from the annular container to a component container received in the central compartment.

2. A centrifuge apparatus according to claim 1, characterised in that the separation compartment communicates with the pressure medium compartment through the intermediary of an elastic diaphragm (8) engaging the annular compartment.

3. A centrifuge apparatus according to claim 1, characterised in that the pressure medium compartment (13) is annular and located below the separation compartment (1) and communicates with the separation compartment through an annular zone between the two compartments and in that the pressure medium compartment extends farther radially inwardly towards the centre of rotation than does the said zone.

4. A centrifuge apparatus according to claims 1-3, characterised in that the elastic body (14) consists of a

material the density of which is greater than that of the liquid to be separated.

5. A centrifuge apparatus according to claim 4, characterised in that the elastic body (14) consists of an elastic material mixed with a heavier solid material.

6. A centrifuge apparatus according to claims 1-3, characterised in that the elastic body (14) consists of an elastic material with metal inserts (49,57) or the like.

7. A centrifuge apparatus according to claims 1-6, characterised in that the elastic body (14) contains one or more embedded bodies containing a liquid.

8. A centrifuge appartus according to claim 1, characterised by one or more centrifugally operated valves (23-25,35-39,40-46) in the centrifuge head for opening and closing connecting ducts between the annular container and the component container or containers in dependence on the rotational speed of the centrifuge head.

9. A centrifuge apparatus according to claim 8, characterised in that the connecting duct or ducts between the containers are collapsible and in that the valves are pinch valves.

10. A centrifuge apparatus according to claim 1, characterised by a slot-like connecting zone between the central compartment and the separation compartment and by a vertically reciprocable, annular pinch member (41) by means of which the slot-like connection can be opened and closed.

11. A centrifuge apparatus according to claim 10, characterised by a centrifugally operated control device (43-46) for the pinch member.

12. A centrifuge apparatus according to claim 1, characterised in that the centrifuge head has an air pressure or vacuum connection (29) through which the separation compartment and/or the central compartment can be pressurized or subjected to vacuum for respectively emptying and filling of the containers.

13. A centrifuge apparatus according to claim 12, characterised in that the vacuum connection is adapted to

be blocked by the annular container upon filling said container with a predetermined quantity of liquid.

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Fig. 1

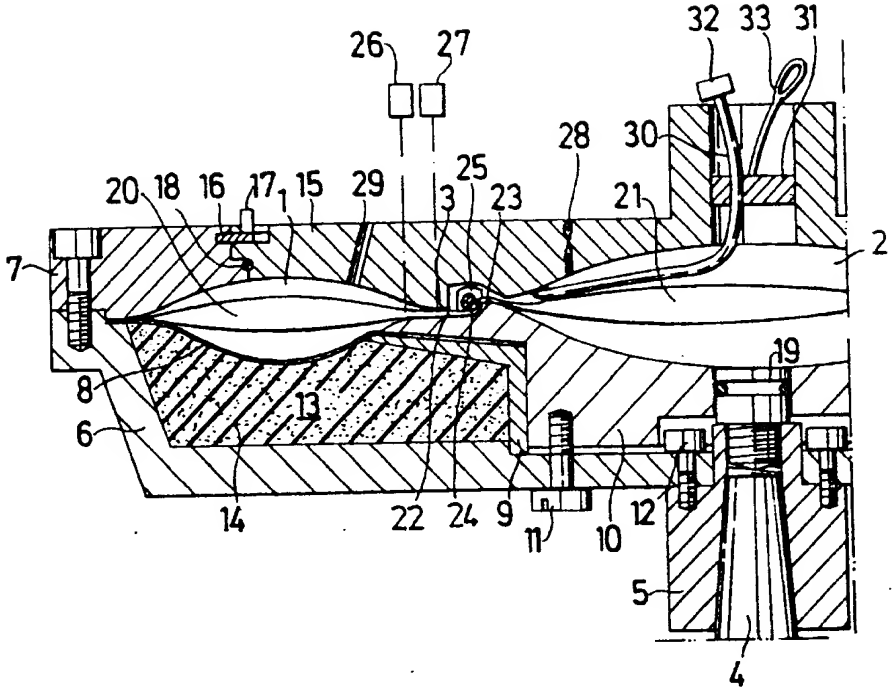

Fig. 2

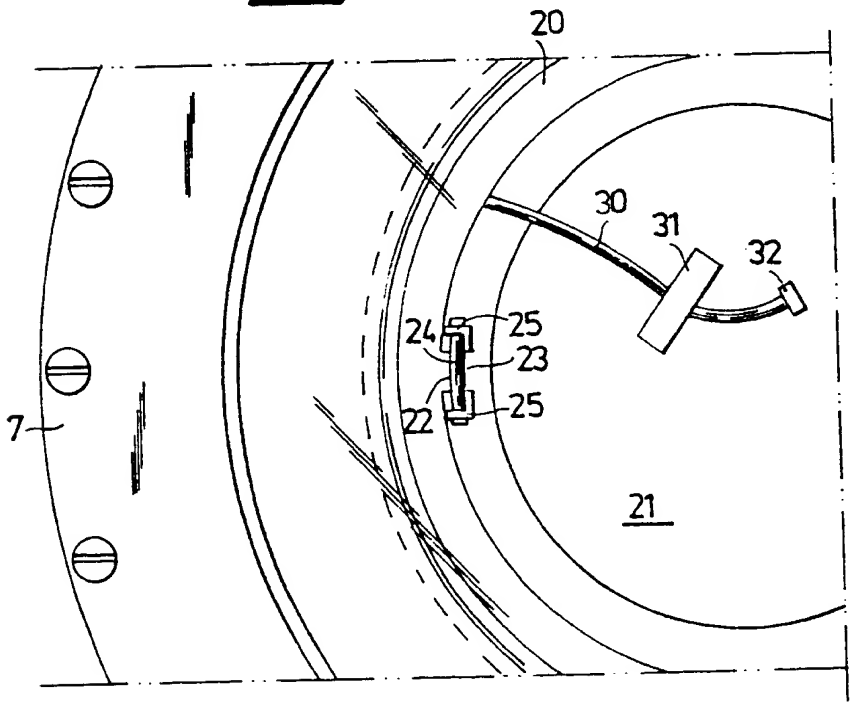

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Fig. 3

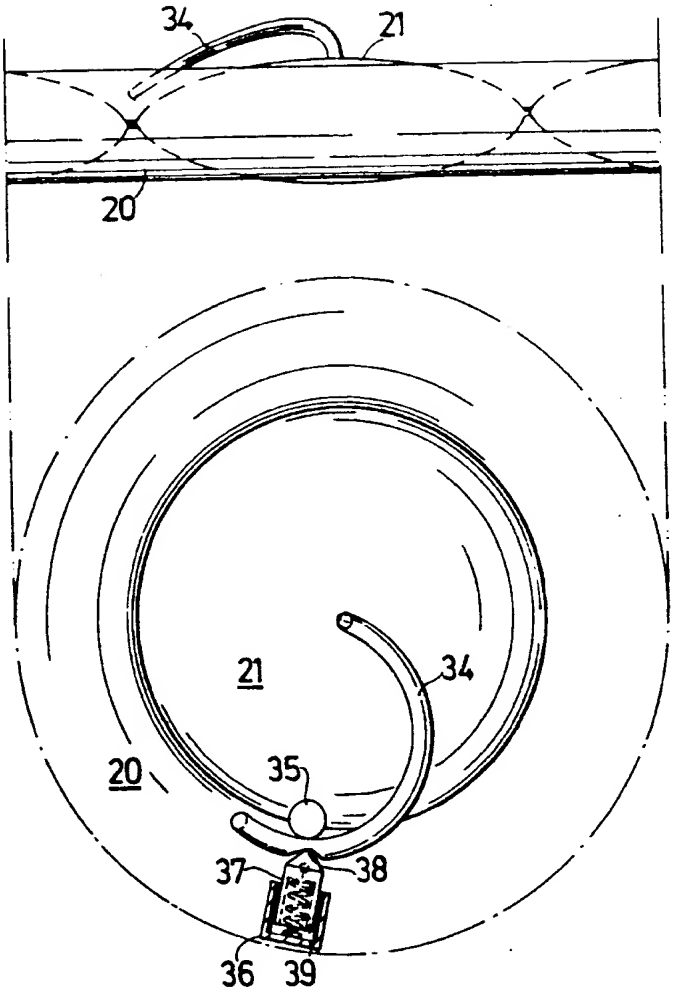


Fig. 4

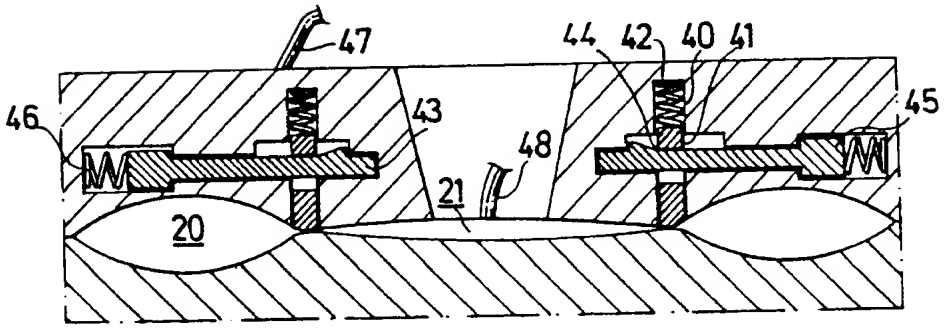


Fig. 5

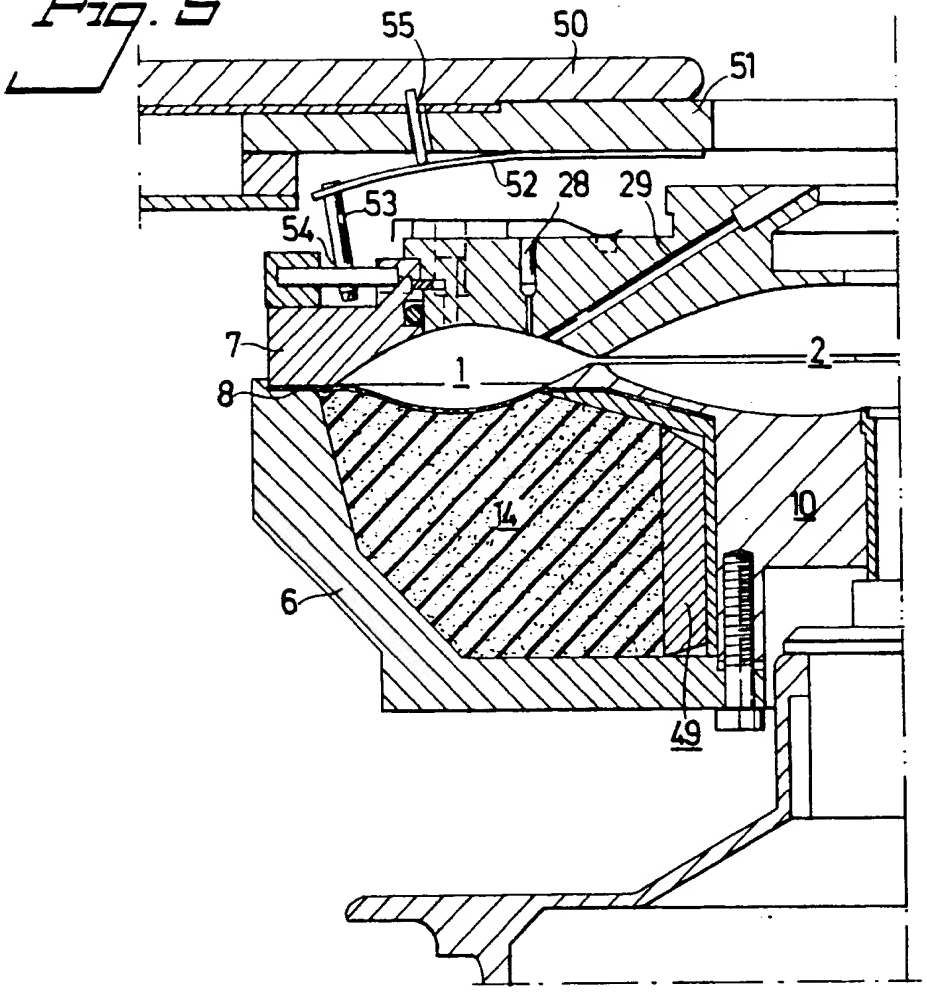
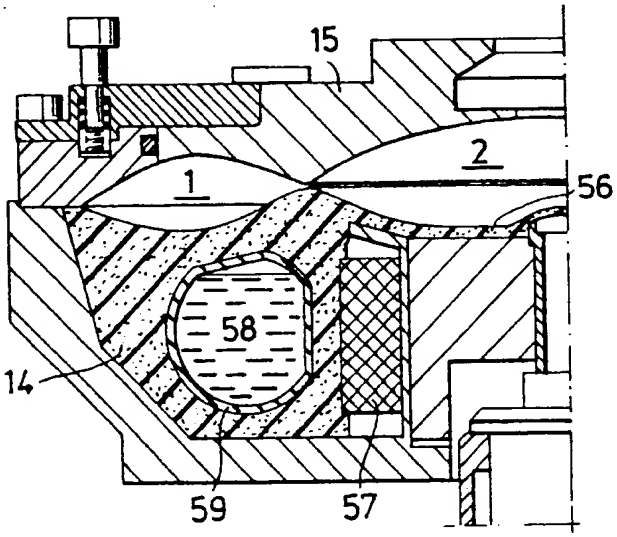


Fig. 6



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00239

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

B 04 B 5/00 4

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B 04 B 5/00-/04, 11/00-/04, 15/00
Nat Cl	42R: 6/01
US Cl	233: 3, 27, 46, 47, 28, 14, 19; 494:1-85

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X,Y	US, A, 3 326 458 (H.T. MERYMAN ET AL) 20 June 1967	1-6
Y	US, A, 3 679 128 (UNGER ET AL) 25 July 1972 & DE, 2039897 FR, 2056830 GB, 1329607 GB, 1329606 BE, 754682 NL, 7011835 DE, 1598538 DE, 1910012 US, 3559880 FR, 2130190 DE, 2212253 US, 3724747 GB, 1373672 US, 3858796 SE, 354582 FR, 2130191 DE, 2212242 GB, 1373671 SE, 354581	1-6

.../...

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-07-22	1987 -07- 24
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Anette Hall

L.E.

Form PCT/ISA/210 (second sheet) (January 1985)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. [X] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. [ ] Claim numbers ....., because they relate to subject matter not required to be searched by this Authority, namely:

Claim 4 ought to be incorporated in claim 1 because the feature mentioned in claim 4 is essential for the working of the centrifuge described in claim 1.

2. [ ] Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. [X] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

Claims 1-10 refers a centrifuge for fractioning whole blood. Claims 11-12 refers to the filling and the emptying of the centrifuge.

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. [X] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4 304 357 (SCHOENDORFER) 8 December 1981	